Next Generation of Li/CFx-MnO_2 primary lithium batteries

Louise Dauga[1], Katia Guérin[1], Marc Dubois[1], Diane Delbègue[2], Yannick Borthomieu[3]

CONTEXT :

For space missions, **Primary Lithium Batteries (PLBs)** are power sources for two specific types of applications

Launchers © CNES

Exploration © CNES

Requirements :

- **High Energy and Power density**
- Wide functioning **temperature range**
- **Low self-discharge**

Current technologies :

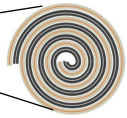
Li/SO_2

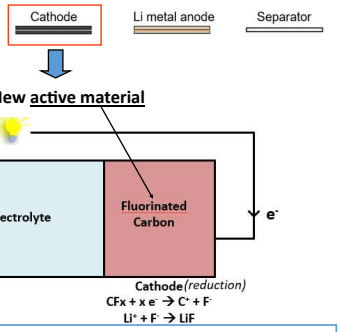
$Li/SOCl_2$

CHALLENGES :

Maximize the energy density of the PLB

SAFT datasheet

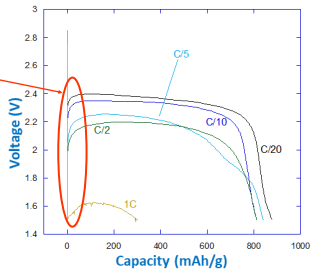




In theory, Fluorinated Carbons (CFx) provide a higher energy density than already known

LIMITATIONS OF Li/CFx PLBs :

CFx is an insulating material. This impacts the performances of battery negatively and results in an **ohmic drop** at the beginning of the discharge



PROPOSED SOLUTION :

Association of CFx with a conductive material

Manganese Dioxide (MnO_2)

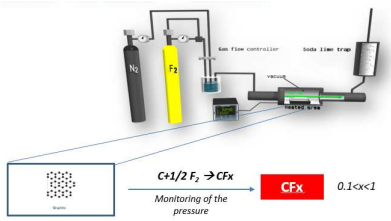
Good conductivity

Already used in primary systems

High Power Density

SYNTHESIS OF A CFx_MnO_2 MATERIAL

Synthesis of a CFx through direct fluorination process :



Graphite is placed in a furnace under vacuum.

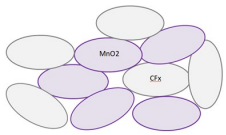
F_2 gas is injected in the furnace and **temperature** is increased

At a given temperature, a **reaction between Graphite and F_2 gas** takes place and there is the formation of **electrochemically active C-F bonds**

Mechanical ball-milling of CFx and MnO_2

80% CFx

20% MnO_2

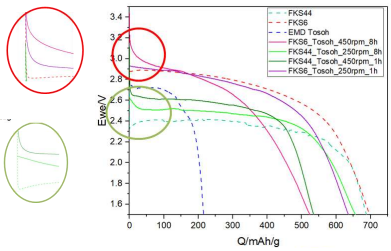


4 materials with different ball-milling parameters

TESTING OF THE CATHODE MATERIALS

The new **CFx_MnO_2** cathode materials were formulated into an **electrode** and assembled in **coin-cells** with a **Lithium metal anode** and a **lithium salt** (LiTFSI) in a mixture of solvents (EC, PC, DMC 1:1:3 vol) as the electrolyte

A **constant current** is then applied to **discharge** the battery . **The voltage** is monitored throughout the discharge



The discharge curves show that the **ohmic drop** at the beginning of the discharge is **greatly reduced**. This shows that the association of CFx with MnO_2 is **beneficial to the performance**.

CONCLUSIONS

1)Adding MnO_2 to CFx leads to better performance in energy and power densities which is what is wanted for space missions

2) The ball-milling conditions define the electrochemistry of the materials. Optimizing these conditions is crucial for the application

3) The nature of the CFx and its structure will also define the performance of the material. Various synthesis parameters can be applied to tune the properties .

4) The exact mechanisms and the nature of the synergy between CFx and MnO_2 must still be investigated

5) The new hybrid materials have already shown promise in bigger scale formats

Pouch-cells format

1 Institut de Chimie de Clermont– Ferrand, Université Clermont Auvergne, Aubière
2 Centre National des études spatiales, Toulouse
3 SAFT, Poitiers